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1 7. BOULDERS – [MODERATE]

- Practicality, how frequently used.
- Placement, arrangement, alignment
- Size and shape
- For juvenile rearing and adult holding habitat
- Scouring, sorting, and stabilization of bed material.
- Supplement ISPG

1.1 Introduction

1.1.1 Description of Technique

A simple technique relying on the strategic placement of large immobile boulders within the river system. Frequently used as a fixed "permanent" feature placed in a homogenous reach

1.1.2 Physical and Biological Effects

- Provides bedform, water depth, and velocity diversity – juvenile rearing, adult holding. Discuss species and age class of fish that would benefit. Note any differences in seasonal use.
- Provides cover, velocity breaks
- Can improve aeration in higher gradient areas
- Promotes scour / sorting

Can also be used to deflect flow or create scour. Refer reader to boulder J-hooks and vortex weirs discussed in technique #8 Structures to create and maintain bed or bank scour.

1.1.3 Application of Technique

- Typical used to create habitat in homogeneous reaches (i.e. channelized reaches)
- Used to enhance bedform, water depth, and velocity diversity – often placed mid-channel
- Limited by equipment access and reach – helicopters are some times used
- Should have a geomorphic (and biologic) rationale for its placement – for instance boulders would not be found and should not be placed in a low gradient sand dominated reach
- Backwatered vs. free-flowing stream reaches
- Stable vs. unstable or degraded stream reaches
- Transport reach vs. depositional reach
- Alluvial vs. non-alluvial stream reach
- Appropriate stream substrate for application
- Appropriate in streams with high bedload or fines?

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- When might use of boulders to create habitat complexity be more appropriate than use of wood?

1.2 Scale

- Small scale – often cost prohibitive
- Small creeks vs large rivers
- Don't need licensed engineer – placement often directed by season fish bio.

1.3 Risk and Uncertainty

- Very limited risk – as boulders are typically immobile

Risk of boulder movement may be low but risk of unintended consequences (excessive bed or bank scour, catching of debris, upstream deposition) may be high if boulders block a significant portion of the channel cross-section.

- Limited risk to infrastructure
- Risk to public safety (kayakers and canoers)
- Limited risk to other habitats
- Effectiveness / Certainty dependent on sediment transport (size, volume etc)

1.4 Data Collection and Assessment

- Other studies / experiences / literature review
- There should be a geomorphic rationale for boulder placement or a rationale for departure
- Sediment, wood, and debris size and transport
- Hydrology and hydraulics
- Biological assessment of habitat needs in subject reach

1.5 Methods and Design

- Simplistic design
- Identify placement sites. What locations will provide the most biological benefit (e.g., bottom half of riffle)?
- Size of boulder based on hydrology / hydraulics
- Arrangement based on professional judgment / experience
- Alignment must consider potential impacts under high flow
- Consider how much of bankfull channel cross-section should be blocked by boulders
- Potential unintended consequences. What channel conditions or boulder configurations are

most likely to cause them?

- Number of boulders per arrangement and frequency/spacing of boulder clusters should be based on reference reach and/or natural channel processes

1.6 Project Implementation

1.6.1 Permitting

- Project Volumes (Cut and Fill), Construction Design and Methods
- Construct Drawings, Plan Views and Maps
- Sediment Control Plan
- Heavy Equipment Fueling Areas and Spill Plan
- Access Area Rehabilitation Plans

1.6.2 Construction

- Fish Species Work Window and Construction Timing
- Equipment Access Areas
- Equipment Size
-
-
- Long reach excavator/helicopter—include hand equipment as well (rock bars and winches)

1.6.3 Cost Estimation

- Costs can be expensive and highly variable (dependent on source of material, transport, installation)

1.6.4 Monitoring and Tracking

Monitoring methods recommended depends of what you're trying to learn. Potential questions include: did the structure stay in place?, did the treatment affect overall fish production in the system?, does the structure provide favorable fish habitat (what fish, season, and age class)? Depending on the objective, and in addition to monitoring elements recommended in Section 5.x.x, the following monitoring activities may include:

- Section and Profile Data
- Bed Substrate Data
- Photo Points
- Boulder-specific scour

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1.6.5 Contracting Considerations

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- Time and materials vs. construction experience
- Contractor experience
- Specifying equipment to be used

1.7 Operations and Maintenance

- Minimal maintenance
- Evaluate need relative to monitoring and objectives.

1.8 Examples

- St. Regis River, Montana (Lere) – example of boulders trapping sediment rather than creating scour
- Inter-Fluve does not have any Washington boulder cluster projects – does WDFW have any they would like to use as examples

1.9 References

References cited in this technique so it is a stand-alone pullout.

1.10 Photo and Drawing File Names

List filenames and file locations of any photos and drawing files associated with this technique

Peter can find a slide of St. Regis boulder clusters – example of inappropriate use due to sed transport, boulders acted as sediment traps rather than creating scour